C. EVALUATION RESULTS

The three basic alternatives that were reviewed include:

1. TP1 – SBR with Chemically Enhanced P-Removal
2. TP7 - Ballasted sedimentation.
3. TP9 – Coagulation followed by direct filtration.
4. TP10 – Upflow filtration

With the exception of TP1, each of these processes is an add-on to the existing process. More details of each of the add-on processes are described below. The Town has previously directed AECOM to examine SBRs with chemically enhanced P-removal. They are a well understood technology and will be explored in the final report in more depth.

TP7 – Ballasted Sedimentation

Ballasted unit processes were selected for further evaluation because of their proven ability at other locations to achieve the low levels of phosphorus in the effluent. Ballasted sedimentation processes use a ballast material such as microsand or other material plus a coagulant and polymer to add density to the coagulated floc to improve settling and phosphorus removal. Examples of these processes include CoMag, Actiflo, and DensaDeg (use of internal recirculation methods to increase floc density).

The advantages of these systems are that they add on to the existing unit processes with the potential to reduce the capital cost of improvements. The downside is that they are mechanically intensive, use chemicals and polymers to achieve the desired results, may need pre-screening, may not fit well into the hydraulic profile, and do not provide any ability to remove nitrogen if this is required in the future.

Example: DensaDeg®

The DensaDeg system uses recycled thickened sludge to add density to the flocculated particles. The system consists of tanks aligned in a certain configuration to which a chemical such as ferric chloride or alum is used as a coagulant. Polymer is added also, and the combined mixture is discharged to a clarifier for settling of the floc. Thickened sludge is recycled, and the waste sludge would need to be processed. The system is proven to reduce phosphorus levels to less than 0.42 mg/l.

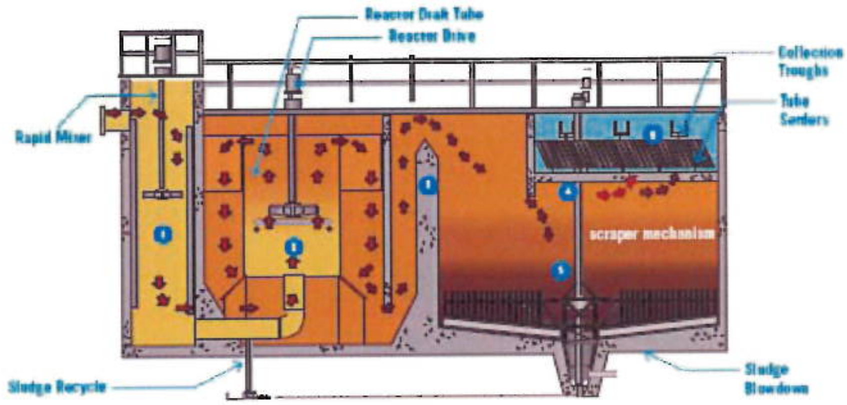


Figure 2-1 DensaDeg® Process Schematic

TP9 – Coagulation Followed by Direct Filtration

Coagulation and filtration processes are well proven to remove phosphorus to low levels. This process is viable for removal of phosphorus to 1.0 mg/l without filters and to less than 0.2 mg/l when filters are used. Chemical precipitation is used to remove the inorganic forms of phosphate by the addition of a coagulant and a mixing of wastewater and coagulant. The multivalent metal ions most commonly used are aluminum or iron. This process requires a mixing device and clarification or filtration. Filtration can be accomplished using single or dual media filters or cloth media filters.

The advantages of these systems are similar to those of ballasted sedimentation processes. They add on to the existing unit processes and have the potential to reduce the capital cost of improvements but they are mechanically intensive, use chemicals and polymers to achieve the desired results, may need pre-screening, may not fit well into the hydraulic profile, and do not provide any ability to remove nitrogen if this is required in the future.

The following is a summary of the theory behind coagulation for phosphorous removal as well as a brief description of each of the potential filtration options.

Aluminum and Iron Coagulation:

Alum or hydrated aluminum sulfate is widely used precipitating phosphates and aluminum phosphates (AlPO4). The basic reaction is:

Al3+ + HnPO43-n ↔ AlPO4 + nH+

The dosage rate required is a function of the phosphorus removal required. The efficiency of coagulation decreases the concentration of phosphorus. In practice, a 70% removal rate is achieved at coagulant dosage rates ranging between 50 and 100 mg/l.

Ferric chloride or sulfate and ferrous sulfate are all widely used for phosphorus removal. The basic reaction for iron salts is:

$Fe^{3+} + H_nPO_4^{3-n} \leftrightarrow FePO_4 + nH^+$

Ferric ions combine to form ferric phosphate. They react slowly with the natural alkalinity and so alkalinity adjustment may be required to raise the pH in order to enhance the coagulation.

Single or Dual Media Filters

There are various combinations of single or dual media filters, however generally they all direct the flow of water down or up through sand or anthracite media. The particles are trapped in the media and removed. Once head loss becomes excessive, the filter is taken out of service and cleaned.

The cleaning requires a back wash system using pumped final effluent that carries the trapped particles out of the media and recycles the sludge to the head of the treatment plant. The back wash rate for most of these types of filters ranges from 5 - 8% of the incoming flow. This technology has been utilized for several decades and would be acceptable.

Cloth Media Filters

Cloth media filters require a much smaller footprint than media filters and significantly less mechanical and power requirements. Cloth media filters generally consist of a hollow frame covered with a synthetic cloth material and supported on a rotating shaft. The core of the frame provides an area which collects the filtered effluent once it has passed through the 10 micron media and then pipes this filtered effluent out to the final discharge. When the cloth media becomes plugged with solids, the rotating frame drive is activated and water is drawn backwards through the media via a small suction head, pipe work and a pump. A small portion of the cloth is taken out of service during the cleaning and approximately 3% of the incoming flow is utilized for backwash.

The advantage of the cloth media filter is the simple operation, reduced backwash flow, smaller site footprint, and significantly reduced capital and operating costs. Cloth media filters are viable for the final polishing step provided they are able to remove algae.

TP10 – Upflow filtration

Upflow filtration technologies filter, absorb and adsorb phosphorous. These systems use a coagulant such as ferric or alum and occasionally a polymer. Coagulation takes place within the filter so a separate coagulation tank is not required. Examples include DynaSand and BluePro.

The advantages of these systems are similar to those of ballasted sedimentation processes. They add on to the existing unit processes and have the potential to reduce the capital cost of improvements but they are mechanically intensive, use chemicals and polymers to achieve the desired results, may need pre-screening, may not fit well into the hydraulic profile, and do not provide any ability to remove nitrogen if this is required in the future.

Example: DynaSand® Parkson

The DynaSand® process is a physical and chemical treatment process, which combines co-precipitation and filtration. The technology uses an automatically cleaning up-flow filter for solids removal. The filter has continuous flow, which allows constant operation without having to shut down for backwashing.

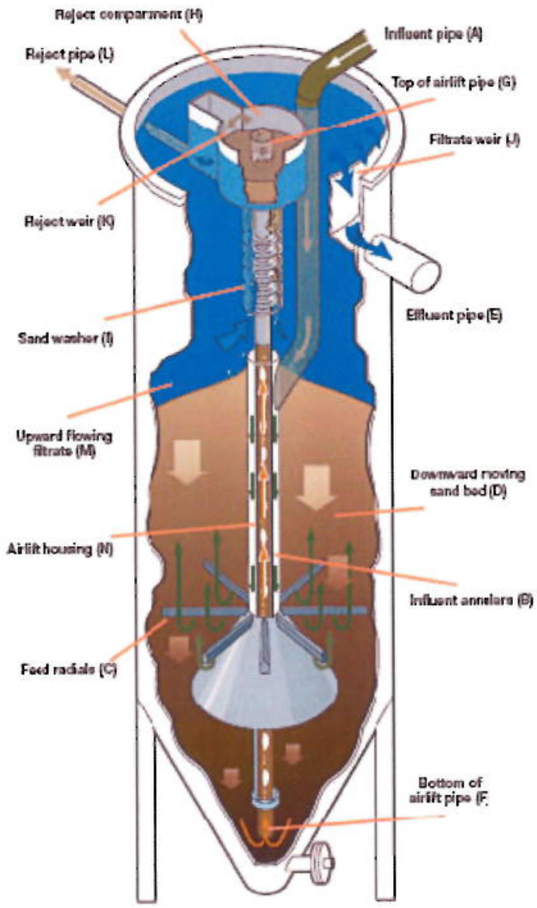


Figure 2-2 DynaSand® Process Schematic

SECTION 3

NITROGEN AND PHOSPHOROUS REMOVAL ALTERNATIVES

A. INTRODUCTION

AECOM's nutrient removal experts also reviewed the available methods of nitrogen removal and discussed options that remove both nitrogen and phosphorous and fit the needs of Newport best. The options that appear to fit the needs of the Town best will be discussed in more detail in the final report but will not be part of the pilot testing. Prior to the workshop, the team reviewed treatment plant records, plant schematics, record drawings, DMR data and reviewed loadings and flows to the plant. The workshop itself was then performed on September 24, 2009. The workshop agenda is provided in Appendix A.

Many of the operational and technical concerns that are important to the phosphorous removal portion of the project are also important for nitrogen and phosphorous removal. The list of these concerns is shown below.

1. Nitrogen removal to less than 8 mg/l. The process needs to be flexible for potential future lower limits;
2. Sustainability;
3. Low temperature operation;
4. Process designed for 1.3 million gallons per day (plant treatment capacity);
5. No increase in odors;
6. Low influent pH;
7. Minimize chemical use;
8. Unknown nutrient loading speciation;
9. Algae growth;
10. Ease of maintenance;
11. Redundancy;
12. Lagoon structural issues;
13. Manual solids processing;
14. Rehabilitate septage handling;
15. Upgrade UV disinfection;
16. Utilize automated process control to allow weekends off.

After this discussion, the workshop participants identified various processes for nitrogen removal. The full range of ideas included:

1. TN1 – SBR with chemically enhanced P-removal
2. TN2 – Convert lagoons to flow-through activated sludge process with secondary clarifiers and chemically enhanced P-removal.

3. TN3 – Cover lagoons, add air, and convert a portion to a denitrification zone with methanol addition. Use chemically enhanced P-removal in the lagoons.
4. TN4 – Submerged Attached Growth Reactor with chemically enhanced P-removal in the lagoons.
5. TN5 – Install a Biological Aerated Filter (BAF) after the lagoons and subsequent P-removal.

B. EVALUATION PROCESS

All processes were presented and discussed with the group. The only process that met with approval by the group for future study was TN1 – SBR with chemically enhanced P-removal. The reasons for dropping the others from consideration are listed below:

1. TN2 – Process control will be difficult in large lagoons. Labor intensive.
2. TN3 – Very little operating experience with this type of process. Risk to potential permit limits is significant. Chemical dependent, and would be difficult to attain lower levels if needed.
3. TN4 – Very little large scale operating experience with this type of process. Risk to potential permit limits is significant. Limited in limits that can be attained.
4. TN5 – Will be very expensive to implement and involves complex operation, chemicals and automated controls. Can accomplish the same goals with fewer unit processes.

APPENDIX A

WORKSHOP AGENDA

9:30 AM – 10:00 AM	Review Existing Plant • Plant schematic • Operations • Discussion of existing unit processes • Missing Info Desired • Notes on Flows and Loading Info
10:00 AM - 10:30 AM	Facilities Planning Discussion • Flows/loadings for design • Expected permit limits • Issues associated with Lagoons
10:30 AM – 10:45 AM	Coffee Break

10:45 AM – 11:45 AM	Nutrient Removal Technologies
	• Phosphorous Removal Technologies
	    o Add-on
	    o In-plant Modifications
	• Nitrogen
	• SBR
	• Rapid Infiltration Basins (RIBs)

11:45 AM – 12:30 PM	Develop Additional Evaluation Criteria
12:00PM – 12:30PM	Working Lunch – catered on site
12:30PM – 5:00PM	Evaluate Processes • Develop three processes to move forward

APPENDIX B

ADD-ON TECHNOLOGIES

Ballasted Sedimentation - Actiflo Technology

Ability to Meet 0.42 mg/L
Yes. This technology has shown the ability to meet less than 0.42 mg/L TP

Lowest Achievable Phosphorus Concentration
This technology has been shown to meet 0.15 mg/L TP on a large operating full-scale application. Pilot data indicates values of 0.1 mg/L.

Ability to Handle Swings (Peaking Factors of 2.5 to 3.0) in Flow
High ability of handle swings in flows because of process configuration.

Ability to Handle to High TSS (50 to 75 mg/L TSS) in the Effluent?
High ability to handle high TSS incoming load. This process commonly used for CSO treatment.

Any Impact of Metals Removal?
Potential positive impact on metals removal

Need to Pilot Technology
Limited Jar Testing Needed. Piloting suggested because of algae.

Any Impacts on Additional Odor Generation
None

Track Record

- North America Operating Facilities for Phosphorus Polishing?
  - >5 Installations in Similar Climates
- Operating Facilities in Other Applications?
  - Prevalent in Water Treatment Industry and in CSO control

Physical Constraints

- **Foot Print**
- Larger than other Ballasted Sedimentation Process
- Sufficient Room Exists

Hydraulic Profile Requirements?

- May or May Not Be Added into Existing Profile for 25 Year Storm
- Additional Head Requirements – May Require Intermediate Pumping

Costs

- **Capital Cost**
  - High Cost Compared to Other Technologies
- **O&M Costs**
  - **Chemical Requirements**
    - Need Polymer at about ½ mg/L dose
    - Need Chemical Coagulant – 30 to 50 mg/L dose
    - Need Micro-sand ballast
  - **Maintenance Requirements**
    - High Degree of Mechanical Equipment
  - **Solids Handling Impacts**
    - Add Back to Plant in Influent
    - Sludge will have a slightly Negative Impact Settling and Dewatering

2.5 % Micro-sand Loss from Process

Power Use

Highest Ballasted Sedimentation Power Use

Operating Labor Costs

Medium Labor Involvement

Other Ancillary Requirements

Micro-sand silo
Bulk Chemical Storage
Chemical Feed Equipment

Operational and Maintenance Non-Cost

Ease of Operation

Requires Functional Control System

Mechanical Complexity

Large Number of Components
No Complex Unique Equipment

Need for Redundancy

Some. Requires Off-the-Shelf Equipment such as pumps for most of the redundancy but also requires some unique equipment that is critical to process operation.

Other Operational Issues

Potential Micro-sand Etching on Down Stream UV Disinfection
Uses Tube Settlers for Solids Separation Requires Periodic Cleaning

Ballasted Sedimentation - CoMag Technology

Ability to Meet 0.42 mg/L?
Yes this technology has shown the ability to meet less than 0.42 mg/L TP

Lowest Achievable Phosphorus Concentration?
This technology has been shown to meet <0.1 mg/L TP on a large operating full-scale application. Pilot data indicates values of 0.05 mg/L with polishing magnetic filter

Ability to Handle Swings in Flow?
High ability of handle swings in flows.

Ability to Handle to High TSS in the Effluent?
High ability to handle high TSS incoming load.

Any Impact of Metals Removal?
Potential Positive Impact on Permitted Metal

Need to Pilot Technology?
Limited Jar Testing Needed. Piloting suggested because of algae.

Any Impacts on Additional Odor Generation?
None

Track Record
- NE Operating Facilities for Phosphorus Polishing?
  - One Concord MA, others in Design
- NA Operating Facilities for Phosphorus Polishing?
  - None New Technology, piloting in Spokane WA
- Operating Facilities in Other Applications?
  - Other Industrial Applications

Physical Constraints
- **Foot Print**
  Smallest Ballasted Sedimentation Process
  Sufficient Room Exists

Hydraulic Profile Requirements?
- Questionable, need to confirm need for 0.2 mm screens
- Additional Head Requirements: Unknown. See above

Costs
- **Capital Cost**
  - Medium Ballasted Sedimentation Capital Cost
- **O&M Costs**
  - **Chemical Requirements**
    - Need Polymer ½ mg/L
    - Need Chemical Coagulant – 30 to 50 mg/L
    - Need Magnetite
  - **Maintenance Requirements**
    - High Degree of Mechanical Equipment
  - **Solids Handling Impacts**

Add Back to Plant in Influent
Sludge will have a slightly Negative Impact Settling and Dewatering
Low Loss of Magnetite from Process

Power Costs

Medium Ballasted Sedimentation Power Cost

Operating Labor Costs

Low Labor Involvement

Other Ancillary Requirements

Magnetite storage
Bulk Chemical Storage
Chemical Feed Equipment

Operational and Maintenance Non-Cost

Ease of Operation

Requires Functional Control System

Mechanical Complexity

Large Number Components
Some Complex Unique Equipment (shear device, polishing magnetic filter, etc.)

Need for Redundancy

Some. Requires Off-the-Shelf Equipment such as pumps for most of the redundancy but also requires some unique equipment that is critical to process operation.

Other Operational Issues

None

Ballasted Sedimentation - DensaDeg Technology

Ability to Meet 0.42 mg/L?
Yes. This technology has shown the ability to meet less than 0.42 mg/L TP

Lowest Achievable Phosphorus Concentration?
This technology has been shown to meet 0.15 mg/L TP on a large operating full-scale application. Pilot data indicates values of 0.1 mg/L.

Ability to Handle Swings in Flow?
High ability of handle swings in flows.

Ability to Handle to High TSS in the Effluent?
High ability to handle high TSS incoming load.

Any Impact of Metals Removal?
Potential Positive Impact on Permitted Metals

Need to Pilot Technology?
Limited Jar Testing Needed. Piloting suggested because of algae.

Any Impacts on Additional Odor Generation?
None

Track Record

- NE Operating Facilities for Phosphorus Polishing?
  - None
- NA Operating Facilities for Phosphorus Polishing?
  - >8 Installations in Similar Climates
- Operating Facilities in Other Applications?

Physical Constraints

- **Foot Print**
- Medium as Compared to other Ballasted Sedimentation Process
- Sufficient Room Exists

Hydraulic Profile Requirements?

- May or May Not Be Added into Existing Profile for 25 Year Storm
- Additional Head Requirements – Possibly None

Costs

- **Capital Cost**
  - Medium Ballasted Sedimentation Capital Cost
- **O&M Costs**
  - **Chemical Requirements**
    - Need Polymer ½ mg/L
    - Need Chemical Coagulant – 30 to 50 mg/L
  - **Maintenance Requirements**
    - Medium Degree of Mechanical Equipment
  - **Solids Handling Impacts**

Add Back to Plant in Influent
Sludge: Will have little Negative Impact Settling and Dewatering

Power Costs
Lowest Ballasted Sedimentation Power Cost

Operating Labor Costs
Low Labor Involvement

Other Ancillary Requirements
Bulk Chemical Storage
Chemical Feed Equipment

Operational and Maintenance Non-Cost

Ease of Operation
Requires a Functional Control System

Mechanical Complexity
Limit Number Components
No Complex Unique Equipment

Need for Redundancy
Requires Off-the-Shelf Equipment

Other Operational Issues
Uses Tube Settlers for Solids Separation Requires Periodic Cleaning

Conventional Filtration Granular Media

Conventional Filtration is not a stand alone technology for phosphorus removal, rather a technology needed to support either biological and/or chemical removal treatment.

Ability to Meet 0.42 mg/L?
Yes. This technology has shown the ability to meet less than 0.42 mg/L TP

Lowest Achievable Phosphorus Concentration?
This technology when used in conjunction with chemical phosphorus removal has been shown to meet <0.1 mg/L TP on a large operating full-scale application.

Ability to Handle Swings (Peaking Factors of 2.5 to 3.0) in Flow?
Granular filters have a limited ability of handle swings in flows. Need to address in number of units available.

Ability to Handle to High TSS (50 to 75 mg/L TSS) in the Effluent?
Have a very limited ability to handle high TSS incoming load. The result is filter blinding and excessive backwashing. Need to address in number of units available.

Any Impact of Metals Addition/Removal?
Potential Positive Impact on Permitted Metals

Need to Pilot Technology?
Not needed. Historically proven.

Any Impacts on Additional Odor Generation?
None

Track Record
- NA Operating Facilities for Phosphorus Polishing?
  - >50 Installations
- Operating Facilities in Other Applications?
  - Used in many other applications

Physical Constraints
- **Foot Print**
  Larger footprint required
  Question if sufficient space exists.

Hydraulic Profile Requirements?
- Additional pumping will be required.
- Typical Head Requirements Estimated at 7 to 8 Feet

Costs
- **Capital Cost**
  - High Capital Cost Due to Concrete Tankage, Underflow System, Media and Backwash Systems

O&M Costs

Chemical Requirements

Not Applicable Since Supports Chemical Phosphorous Removal

Maintenance Requirements

Medium Complexity, Complexity Centered on Backwash Equipment

Solids Handling Impacts

Backwash Add Back to Plant in Influent

Sludge Will Negatively Impact Settling and Dewatering

Power Use

High Due to Increased Head Needed, Backwash Cycle.

Operating Labor Costs

Low Labor Involvement

Other Ancillary Requirements

Backwash System and Backwash Wet Well

Operational and Maintenance Non-Cost

Ease of Operation

Easy to Operate, Little Operator Involvement

Mechanical Complexity

Low

No Complex Unique Equipment

Need for Redundancy

N+1+1 Redundant Cells Will Be Required

Other Operational Issues

None

Conventional Filtration Fabric

Conventional Filtration is not a stand alone technology for phosphorus removal, rather a technology needed to support either biological and/or chemical removal treatment.

Ability to Meet 0.42 mg/L?
Yes. This technology has shown the ability to meet 0.42 mg/L TP

Lowest Achievable Phosphorus Concentration?
This technology when used in conjunction with chemical phosphorus removal has been shown to meet between 0.15 to 0.2 mg/L TP on a large operating full-scale application.

Ability to Handle Swings (Peaking Factors of 2.5 to 3.0) in Flow?
Fabric filters have a limited ability of handle swings in flows. Need to address in number of units available.

Ability to Handle to High TSS (50 to 75 mg/L TSS) in the Effluent?
Have a very limited ability to handle high TSS incoming load. The result is filter blinding and excessive backwashing.

Any Impact of Metals Addition/Removal?
Likely Positive Impact on Permitted Metal

Need to Pilot Technology?
Yes because of algae

Any Impacts on Additional Odor Generation?
None

Track Record

- NA Operating Facilities for Phosphorus Polishing?
  - >25 Installations
- Operating Facilities in Other Applications?
  - Used in many other applications

Physical Constraints

Foot Print
Small footprint required
Sufficient Room Exists

Hydraulic Profile Requirements?
Additional pumping may not be required; may fit into existing hydraulic profile for 25 year storm.

Costs

Capital Cost
Low Capital Cost

O&M Costs

Chemical Requirements

Not Applicable Since Supports Chemical Phosphorous Removal

Maintenance Requirements

Low Complexity, Complexity Only Centered on Backwash Equipment

Solids Handling Impacts

Backwash Add Back to Plant in Influent

Sludge Will Negatively Impact Settling and Dewatering

Power Use

Low

Operating Labor Costs

Low Labor Involvement

Other Ancillary Requirements

Backwash System and Backwash Wet Well Required

Operational and Maintenance Non-Cost

Ease of Operation

Easy to Operate, Little Operator Involvement

Mechanical Complexity

Low

No Complex Unique Equipment

Need for Redundancy

N+1 Redundant Units Will Be Required

Other Operational Issues

None

Upflow Continuous Filtration - 2 Stage Dynasand

Ability to Meet 0.42 mg/L?
Yes. This technology has shown the ability to meet less than 0.42 mg/L TP

Lowest Achievable Phosphorus Concentration?
This technology has been shown to meet <0.1 mg/L TP for many small applications.
Pilot data indicates values of < 0.1 mg/L.

Ability to Handle Swings in Flow?
Does not have much ability to handle swings in flows.

Ability to Handle to High TSS in the Effluent?
Does not have the ability to handle high TSS incoming load.

Any Impact of Metals Removal?
Potential Positive Impact on Permitted Metal

Need to Pilot Technology?
Limited Jar Testing Needed. Piloting suggested because of algae.

Any Impacts on Additional Odor Generation?
None

Track Record

- NE Operating Facilities for Phosphorus Polishing?
  - None
- NA Operating Facilities for Phosphorus Polishing?
  - >8 Installations in NY State
- Operating Facilities in Other Applications?
- Similar technology for a variety of other applications.

Physical Constraints

- **Foot Print**
- High as Compared to other Phosphorus Polishing Processes
- Sufficient Room Exists

Hydraulic Profile Requirements?

- Does not have the Ability to Be Added into Existing Profile for 25 Year Storm
- Additional Pumping Head Will Be Needed

Costs

- **Capital Cost**
  - High Capital Cost
- **O&M Costs**
  - **Chemical Requirements**
    - Need Chemical Coagulant – 20 to 30 mg/L
  - **Maintenance Requirements**
    - Medium Degree of Mechanical Equipment, but Many Units Needed
  - **Solids Handling Impacts**

Add Back to Plant in Influent
Sludge Will Have Some Negative Impacts to Settling and Dewatering

Power Costs
High Power Cost

Operating Labor Costs
Medium Labor Involvement

Other Ancillary Requirements
Bulk Chemical Storage
Chemical Feed Equipment

Operational and Maintenance Non-Cost

Ease of Operation
Required Functional Control System

Mechanical Complexity
Many Unit Process Needed
No Complex Unique Equipment

Need for Redundancy
Piloting will determine needs due to hydraulics and algae. Could be significant.

Other Operational Issues

Dissolved Air Flotation - Aqua-DAF Technology

Ability to Meet 0.42 mg/L?
Yes. This technology has shown the ability to meet less than 0.42 mg/L TP

Lowest Achievable Phosphorus Concentration?
This technology has been shown to meet 0.15 mg/L TP on a large operating full-scale application. Pilot data indicates values of 0.1 mg/L.

Ability to Handle Swings (Peaking Factors of 2.5 to 3.0) in Flow?
High ability of handle swings in flows.

Ability to Handle to High TSS (50 to 75 mg/L TSS) in the Effluent?
High ability to handle high TSS incoming load.

Any Impact of Metals Addition/Removal?
Potential Positive Impact on Permitted Metal

Need to Pilot Technology?
Limited Jar Testing Needed. Piloting suggested for algae.

Any Impacts on Additional Odor Generation?
None

Track Record

- NA Operating Facilities for Phosphorus Polishing?
  - >5 Installations in Similar Climates
- Operating Facilities in Other Applications?
  - Prevalent in Water Treatment Industry

Physical Constraints

- **Foot Print**
  - Larger than other Ballasted Sedimentation Process
  - Sufficient Room Exists

Hydraulic Profile Requirements?

- May or May Not Be Added into Existing Profile for 25 Year Storm
- Additional Head Requirements - Possibly None

Costs

- **Capital Cost**
  - High Ballasted Sedimentation Capital Cost
- **O&M Costs**
  - **Chemical Requirements**
    - Need Polymer ½ mg/L
    - Need Chemical Coagulant – 30 to 50 mg/L
  - **Maintenance Requirements**
    - High Degree of Mechanical Equipment
  - **Solids Handling Impacts**
    - Add Back to Plant in Influent
    - Sludge Will slightly Negative Impact Settling and Dewatering
    - **Power Use**

Highest Power Use

Operating Labor Costs

High Labor Involvement

Other Ancillary Requirements

Bulk Chemical Storage

Chemical Feed Equipment

Operational and Maintenance Non-Cost

Ease of Operation

Requires Functional Control System

Mechanical Complexity

Large Number of Components

No Complex Unique Equipment

Need for Redundancy

Some. Requires Off-the-Shelf Equipment such as pumps and compressors for most of the redundancy.

Other Operational Issues

Appendix F

INFILCO DEGREMONT INC.

DensaDeg® - High Rate Clarifier/Thickener

Pilot Study Report – Town of Newport, NH

Infilco Degremont Inc.
8007 Discovery Drive
Richmond, VA 23229

Tel: 804.756.7600
Fax: 804.756.7643
Bryce.Carter@infilcodegremont.com

December 18, 2009
REV 2

TABLE OF CONTENTS

1. INTRODUCTION

Infilco conducted a DensaDeg® pilot study at the Newport Wastewater Treatment Plant in Newport, New Hampshire following an invitation by the Town of Newport and AECOM. The DensaDeg® high-rate clarifier/thickener was tested as a solution to tertiary phosphorous and orthophosphate removal. The pilot study was conducted from November 2 to November 24, 2009.

1.1 OBJECTIVES OF THE STUDY

AECOM, based out of Concord, MA, is currently investigating treatment technologies for Tertiary Total Phosphorus (TP) and orthophosphate (reactive phosphorous) removal for the Newport Wastewater Treatment Plant (WWTP). The Newport WWTP has a permitted capacity of 1.3 MGD and has Total Phosphorous levels that exceed the newly issued NPDES permitted seasonal limits of less than 0.42 mg/L TP between April 1 and October 31, and less than 1.0 mg/L between November 1 and March 31. In an effort to improve the quality of their final effluent discharge, the Town of Newport evaluated several advanced technologies for Total Phosphorous and orthophosphate removal. One of the technologies evaluated was the DensaDeg® high rate clarifier/ thickener process from Infilco Degremont, Inc.

The main objective of the testing was to confirm the effectiveness of the DensaDeg® process for Total Phosphorous removal from the final effluent at the Newport WWTP. In order to provide a detailed evaluation of the DensaDeg® process, several parameters were investigated:

The DensaDeg® was tested primarily for its ability to remove both effluent Total Phosphorous and orthophosphate concentrations at various surface loading rates (up to 8.5 gpm/ft^2) using both Aluminum Sulfate and Ferric Chloride as coagulants. Additionally, testing was performed to access the impact of the DensaDeg® on water quality parameters including algae removal, effluent TSS, BOD_5, alkalinity, pH, and UV 254. The data collected from the pilot study will be used to support determination of a full-scale process design.

1.2 IDENTIFICATION OF PARTICIPANTS

Pilot study evaluation of the DensaDeg® treatment process required the collaborative efforts of several parties, briefly described below.

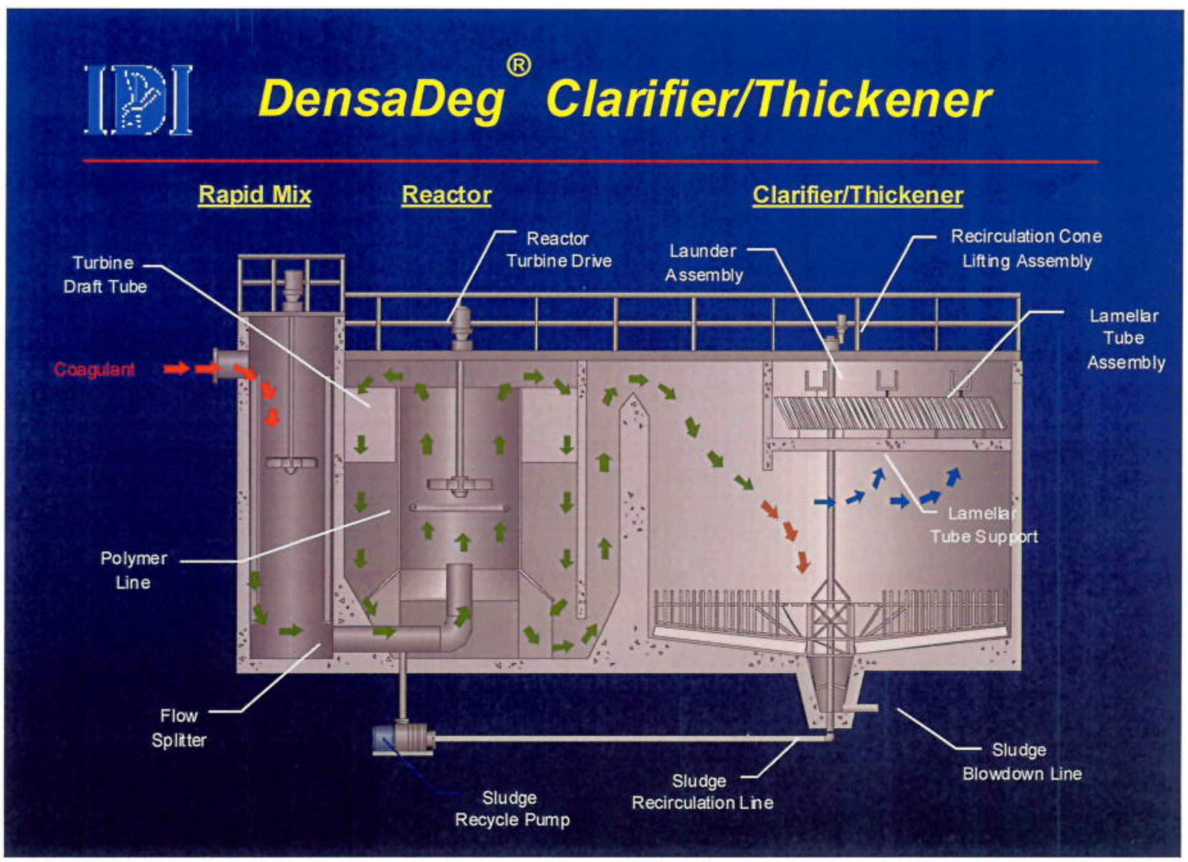
- **Infilco Degremont Inc.** - Provided the pilot unit, equipment start-up, daily operations, sample collection, and the final pilot study report.
- **AECOM** - Overall pilot testing plan and lab sample analysis.
- **Newport Wastewater Treatment Plant** - Assisted with the installation of the pilot, provided power and water, and sample collection.

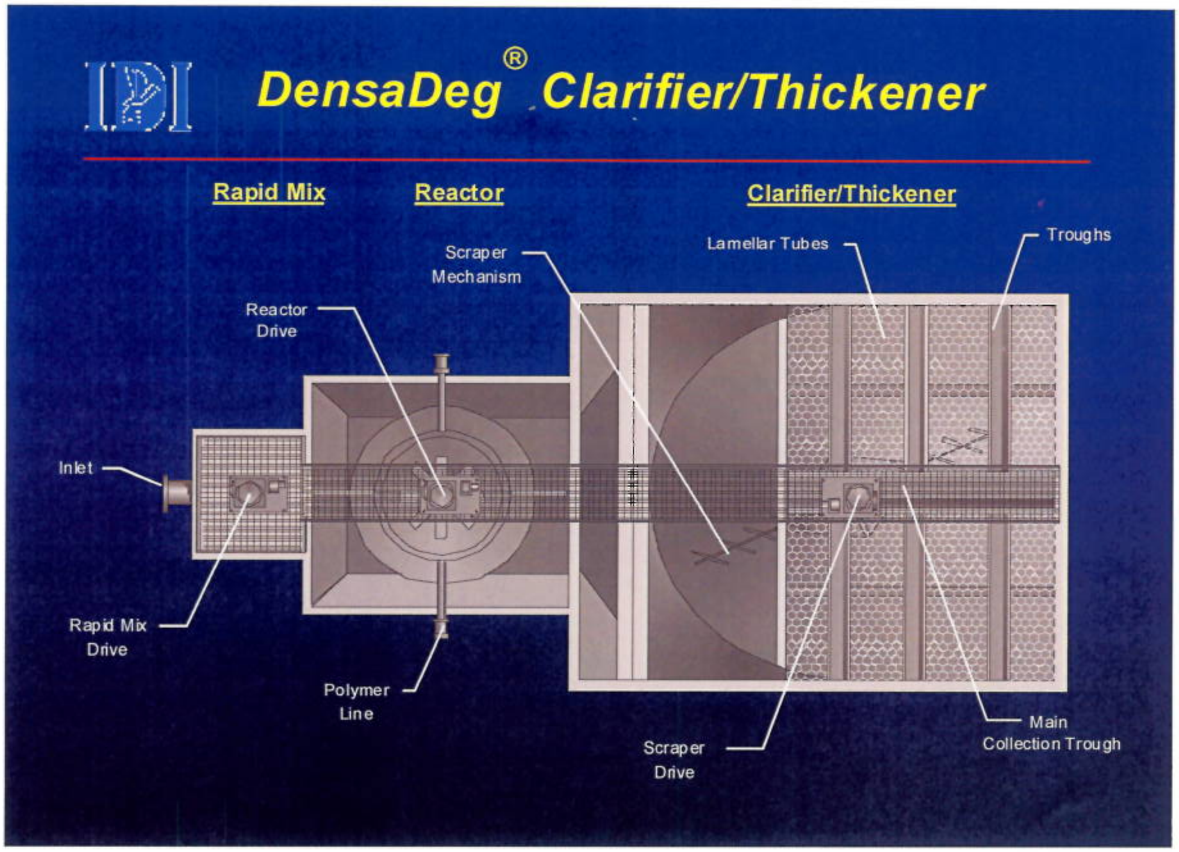
2. DensaDeg® PROCESS

The DensaDeg® is a high-rate solids contact clarifier which combines optimized flocculation, internal and external sludge recirculation, sludge thickening, and lamellar settling to achieve high hydraulic loading and treatment efficiencies. The process combines solids contact through internal and external sludge recirculation in a single treatment unit. This method produces a dense flocculate with a high settling rate without the need to add additional ballast material, such as sand. The DensaDeg® is proficient in the field of physical-chemical treatment of wastewater and has been employed for a wide range of municipal and industrial applications.

As illustrated in figure 1, the DensaDeg® Clarifier is comprised of three integral process zones: the rapid mix, the reactor, and the clarifier/thickener. The function of these zones is described in more detail in the following three sections.

FIGURE 2.1 - Typical DensaDeg® Cross-Section & Flow Diagram





2.1. DESCRIPTION OF THE DensaDeg® PROCESS

2.1.1 RAPID MIX

Influent raw water begins treatment by entering the rapid mixing zone. The sole purpose of the rapid mix tank is to begin coagulation through the addition and even distribution of a coagulant. The coagulants used in this study, Aluminum Sulfate or Ferric Chloride, are injected directly into the inlet pipe or upstream in the feed channel. The addition of the coagulant facilitates the agglomeration of colloid particles in the raw water in preparation for chemical reactions to occur in the reactor tank.

2.1.2 THE REACTOR

The water is then transferred into the reactor zone at the bottom of the reactor basin beneath an axial flow impeller. Inside this draft tube, polymer is injected through a distribution ring into the coagulated water. This polymer addition aids in the flocculation and settleability of the coagulated particles. Recycled solids are introduced at the inlet pipe to the reactor to aid in flocculation. The movement of the impeller provides sufficient energy for the mixing of chemicals and raw water. Additionally, this serves as an axial flow pump by drawing previously formed solids, which settle external to the flume, into the base of the flume. This internal recycling of previously formed solids enhances the solids contact process and increases the speed of the reactions. Next, the densely structured precipitate is transitioned from the reactor basin through a piston flocculation zone where it can begin to settle and thicken. Here, the dynamic separation of the solids and the supernatant occurs. As the slurry begins to settle to a point near the bottom of the reaction vessel, it is forced to make a 180-degree turn beneath the baffle, which vertically divides the vessel. After making this turn, the slurry then enters the clarifier/thickener.

2.1.3 THE CLARIFIER AND THICKENER

Due to the density of the solids within the slurry, nearly all of the solids are deposited on the bottom of the thickener basin. Here the solids are allowed to thicken with the aid of a slowly rotating scraper mechanism. This process maintains the homogeneity of the solids, while facilitating further release of entrained water. Thickened sludge is periodically wasted from the bottom of the thickener and is typically pumped directly to a final dewatering process. A portion of the sludge inventory is recycled back to the reactor basin, thereby increasing the solids in the reactor and improving the performance of the process. A recycle rate of 2 to 4 percent of the influent flow rate was used for the duration of this study. Additional solids removal is achieved by the use of lamellar tubes incorporated into the top of the clarification zone. Moving through the lamellar tubes, finished water is collected through a series of launders or laterals which discharge treated water into the effluent trough.

3. DESCRIPTION OF PILOT EQUIPMENT

The DensaDeg® pilot is a skid-mounted unit, complete with the applicable process treatment equipment, including chemical feed and mixing equipment, flow meters and effluent turbidity meters.

3.1 OPTIMIZATION OF DENSADEG® PROCESS VARIABLES

As part of the pilot plant start-up, optimization of all process variables must be performed in order to find the optimum conditions before the evaluation of DensaDeg® performance on the raw water supply.

Due to the abbreviated pilot study timeline, the optimization process was shortened to focus on equipment function and building a sludge blanket inside the clarifier. Once this process was complete, a baseline chemical dosage was determined using commonly accepted coagulant to phosphorus ratios and polymer dosages from previous DensaDeg® pilot studies.

3.1.1 CHEMICAL AND PH OPTIMIZATION

Two coagulants, Aluminum Sulfate and Ferric Chloride, were evaluated in this pilot study. The optimal coagulant dose was selected based on effluent turbidity and Total Phosphorous removal. The pH was not adjusted during the study. The following coagulant dosages were tested:

- Aluminum Sulfate – 65, 75, 80, 85 ppm
- Ferric Chloride – 45, 55, 65, 70, 75, 80 ppm

See section '5.0 DensaDeg® Pilot Test Results' for details on each chemical optimization run.

3.1.2 DENSADEG® LOADING RATE

The loading rate across the DensaDeg® lamellar area is directly proportional to flow. Therefore, as the flow to the pilot increases, the DensaDeg® loading rate increases.

The pilot has a hydraulic capacity of approximately 200 gpm and was operated at flow rates of 58 to 90 gpm, yielding 5.5 to 8.5 gpm/ft^2. The DensaDeg® operated successfully at all loading rates within this range.

4. Pilot Study Protocol

4.1 PILOT PLANT OBJECTIVES

The pilot test protocol employed for this 3-week study was created by AECOM. The protocol provided specific directives for performance evaluation of the DensaDeg® system for tertiary treatment to remove Total Phosphorous.

DensaDeg® performance capabilities were evaluated under the following sub-tasks:

4.1.1 COAGULANT & POLYMER DOSE OPTIMIZATION

The first days of each phase (Aluminum Sulfate and Ferric Chloride) of the study were used to determine the optimal coagulant and polymer doses required to treat the raw water to the <0.35 mg/L effluent Total Phosphorous goal. The DensaDeg® has a retention time, based only on the flow, between 18 and 72 minutes. Therefore, changes made to the coagulant and polymer dose were allowed 2 to 3 hours to stabilize. Because there was a one-week turnaround on the phosphorous lab samples, an onsite phosphate tester was used to estimate the effectiveness of the removal. From this information and the effluent turbidity, the optimal coagulant dose was determined. The polymer tested was LT22 (a very high molecular weight, medium charge density, dry, anionic polymer).

4.1.2 RISE RATE EVALUATION TO IDENTIFY MAXIMUM OPERATING RISE RATE FOR COMPLETE TREATMENT

The DensaDeg® pilot can be operated at multiple hydraulic loading rates. During this study, the majority of the testing was performed between 5.5 and 8.5 gpm/ft^2 (the designed rate). This part of the protocol was used to show the flexibility of the DensaDeg®'s operating flow rates.

4.1.3 SLUDGE PRODUCTION AND DISPOSAL

The quantities of sludge produced will vary based on the flow of water to be treated, the concentration of suspended solids and organics in the raw water, coagulant and polymer dosages, and any other added or precipitated products.

The DensaDeg® pilot sludge removal system consists of a large scraper and a pneumatic valve that opens at the bottom of the clarifier. The control panel on the pilot controls the duration and frequency the valve is open. The water level in the DensaDeg® hydraulically pushes the thickest sludge out of the bottom of the tank when the valve opens.

4.1.4 FREQUENCY OF SAMPLING & ANALYSIS

The primary parameters used to assess the DensaDeg® pilot performance were turbidity and Total Phosphorus because these analytical results could be obtained within a short turnaround time. An online turbidimeter provided grab sample turbidity measurements, which were used to help determine when steady-state conditions or consistent effluent quality was attained following the start-up of a test run. Grab samples of raw water influent and DensaDeg® effluents were collected after every hour in a test run. All grab samples were analyzed on-site for Total Phosphorus, turbidity, and pH.

5. DensaDeg® Pilot Results

The pilot study results from the Town of Newport Tertiary Phosphorous removal pilot study demonstrates that the DensaDeg® process is capable of effectively removing Total Phosphorus to well below the required NPDES permit levels. This high rate solids contact clarifier and thickener process is a viable solution to increase effluent production with minimum solid waste production.

Specific conclusions are as follows:

The DensaDeg® was tested successfully at an application rate of 5.5 - 8.5 gpm/ft^2 using both Aluminum Sulfate and Ferric Chloride.

Effective coagulant doses to consistently meet NPDES requirements during the study were as follows:

- Aluminum Sulfate – 75 - 85 ppm
- Ferric Chloride – 55 - 80 ppm

Final Total Phosphorous levels in the DensaDeg® effluent successfully met the study objective outlined by the town's NPDES Criteria for effluent discharge, consistently producing less than 0.25 mg/L P with Aluminum Sulfate and less than 0.1 mg/L P with Ferric Chloride.

The DensaDeg® effluent turbidity was stable (< 1.0 NTU using ferric and < 2.0 NTU using alum) through an influent turbidity range of 4.5 to 25.0 NTU.

During the hydraulic variation test the DensaDeg® successfully maintained effluent turbidity < 1.0 NTU.

***Please note that the influent turbidimeters were being fouled regularly by suspended solids and the abundance of daphnia. Therefore, all spikes in the influent and effluent turbidity are not in error, but rather from regular cleaning of the turbidimeters, unless otherwise shown as following an increase in rise rate.**

FIGURE 5.1: TURBIDITY DATA FOR ALUMINUM SULFATE

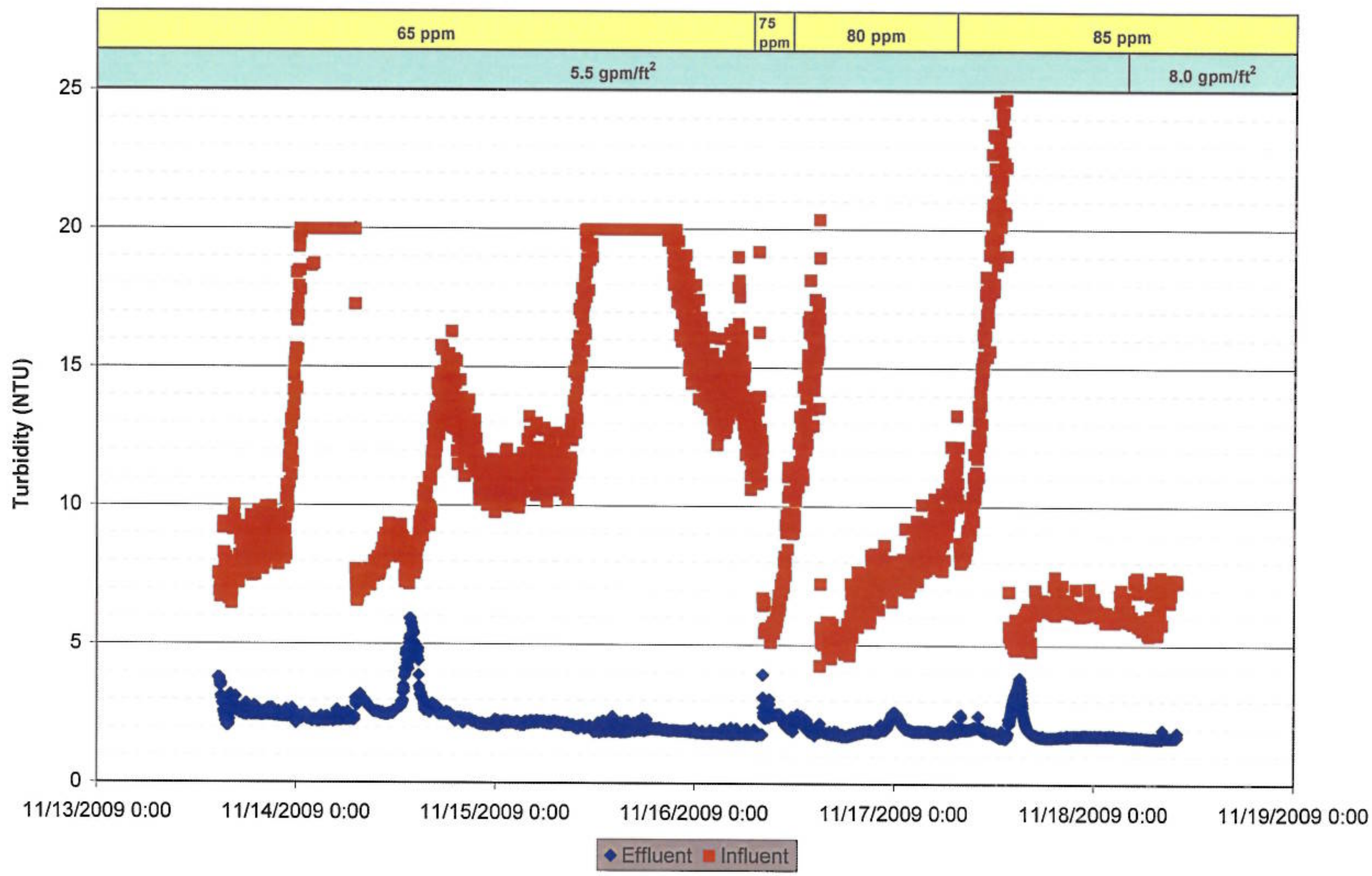


FIGURE 5.2: THE EFFECT OF ALUMINUM SULFATE ON PHOSPHOROUS REMOVAL

Date	Time	Influent Flow Rate	Loading Rate	Alum Dose	Polymer Dose	Influent PO_4	Effluent PO_4	Influent P	Effluent P
		(gpm)	(gpm/ft^2)	(ppm)	(ppm)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
11/14/2009	6:00	57.85	5.4	65	0.8	>2.75	0.79	>0.92	0.26
11/14/2009	7:20	57.66	5.4	65	0.8	>2.75	0.89	>0.92	0.30
11/16/2009	7:02	57.62	5.4	65	0.9	>2.75	0.54	>0.92	0.18
11/16/2009	8:30	57.54	5.4	65	0.9	>2.75	0.51	>0.92	0.17
11/16/2009	9:30	57.91	5.4	65	0.89	>2.75	0.67	>0.92	0.22
11/16/2009	10:30	57.65	5.4	75	0.89	>2.75	0.38	>0.92	0.13
11/16/2009	11:30	58.33	5.5	75	0.89	>2.75	0.28	>0.92	0.09
11/16/2009	13:00	57.97	5.4	75	0.9	>2.75	0.64	>0.92	0.21
11/16/2009	14:15	58.26	5.4	80	0.77	>2.75	0.71	>0.92	0.24
11/17/2009	6:30	57.72	5.4	80	0.87	>2.75	0.19	>0.92	0.06
11/17/2009	7:30	57.91	5.4	80	0.87	>2.75	0.34	>0.92	0.11
11/17/2009	8:30	57.93	5.4	80	0.87	>2.75	0.53	>0.92	0.18
11/17/2009	9:30	56.70	5.3	80	0.87	>2.75	0.45	>0.92	0.15
11/17/2009	10:33	57.17	5.3	85	0.87	>2.75	0.33	>0.92	0.11
11/17/2009	11:30	57.48	5.4	85	0.8	>2.75	0.32	>0.92	0.11
11/17/2009	13:07	57.73	5.4	85	0.8	>2.75	0.43	>0.92	0.14
11/17/2009	14:08	57.38	5.4	85	0.91	>2.75	0.66	>0.92	0.22
11/17/2009	14:30	57.79	5.4	85	0.91	>2.75	0.62	>0.92	0.21
11/18/2009	7:15	84.67	7.9	85	0.91	>2.75	0.39	>0.92	0.13
11/18/2009	8:15	84.50	7.9	85	0.93	>2.75	0.49	>0.92	0.16
11/18/2009	9:15	85.35	8.0	85	0.95	>2.75	0.36	>0.92	0.12

FIGURE 5.3: TURBIDITY DATA FOR FERRIC CHLORIDE

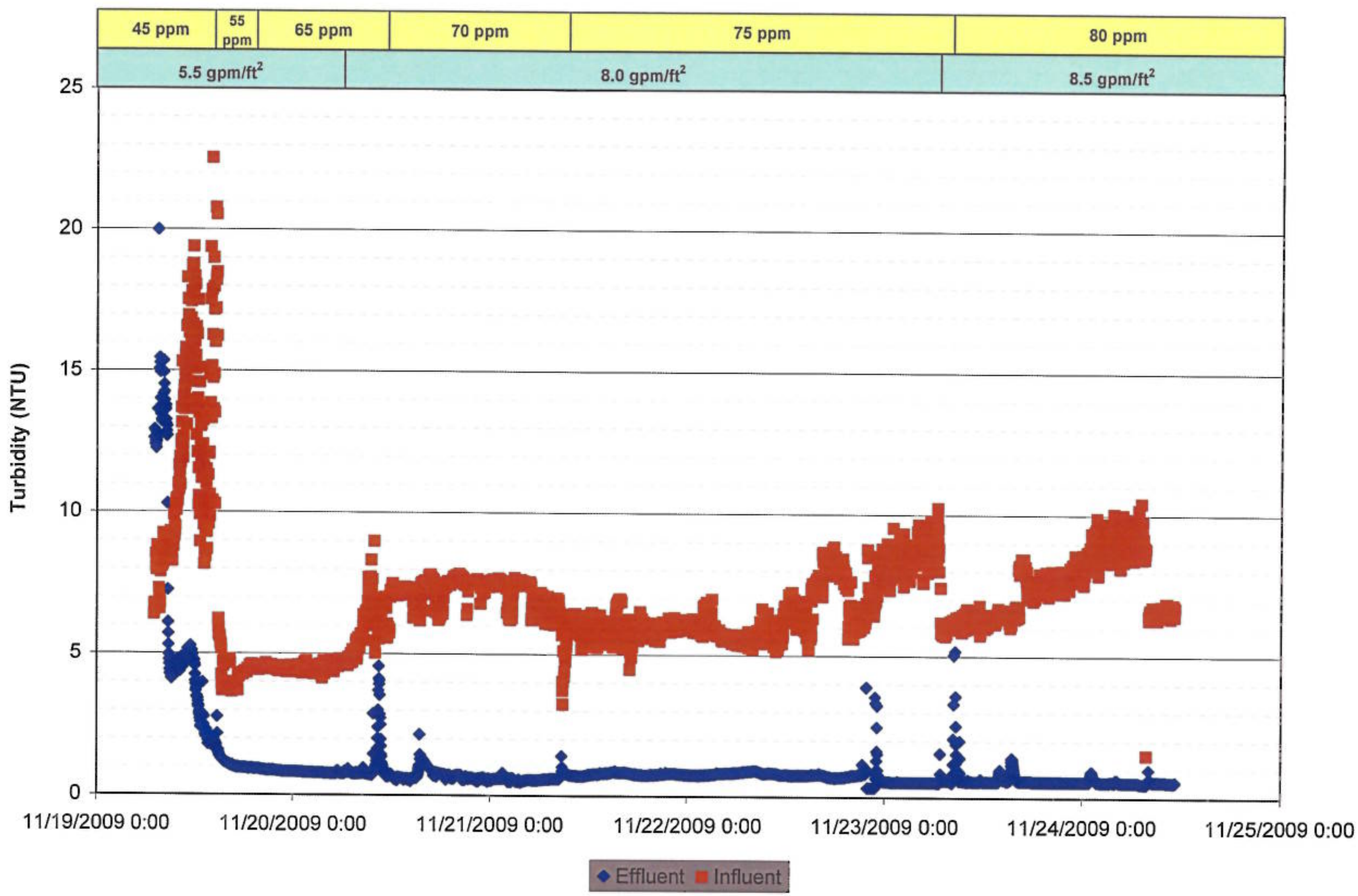


FIGURE 5.4: THE EFFECT OF FERRIC CHLORIDE ON PHOSPORUS REMOVAL

Date	Time	Influent Flow Rate	Loading Rate	Ferric Dose	Polymer Dose	Influent PO_4	Effluent PO_4	Influent P	Effluent P
		(gpm)	(gpm/ft^2)	(ppm)	(ppm)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
11/18/2009	14:38	85.41	7.98	45	0.90	>2.75	1.14	>0.92	0.38
11/19/2009	7:00	84.52	7.90	45	0.96	>2.75	>2.75	>0.92	0.92
11/19/2009	10:00	58.12	5.43	45	0.96	>2.75	1.35	>0.92	0.45
11/19/2009	11:00	58.45	5.46	45	0.96	>2.75	1.41	>0.92	0.47
11/19/2009	12:30	58.93	5.51	55	0.96	>2.75	0.69	>0.92	0.23
11/19/2009	13:40	58.51	5.47	55	0.96	>2.75	0.43	>0.92	0.14
11/19/2009	14:55	59.02	5.52	65	0.90	>2.75	0.43	>0.92	0.14
11/19/2009	15:15	59.36	5.55	65	0.90	>2.75	0.37	>0.92	0.12
11/20/2009	7:30	58.28	5.45	65	0.90	>2.75	0.27	>0.92	0.09
11/20/2009	9:30	58.28	5.45	65	0.90	>2.75	0.27	>0.92	0.09
11/20/2009	10:30	70.79	6.62	70	0.90	>2.75	0.89	>0.92	0.30
11/20/2009	11:10	70.60	6.60	70	0.90	>2.75	0.27	>0.92	0.09
11/20/2009	12:30	85.32	7.97	70	0.90	>2.75	0.30	>0.92	0.10
11/20/2009	13:45	85.41	7.98	70	0.90	>2.75	0.40	>0.92	0.13
11/21/2009	8:00	35.77	3.34	75	0.85	>2.75	0.23	>0.92	0.08
11/23/2009	9:00	90.83	8.49	75	0.85	>2.75	0.19	>0.92	0.06
11/23/2009	10:00	90.40	8.45	80	0.85	>2.75	0.22	>0.92	0.07
11/23/2009	11:00	91.66	8.57	80	0.85	>2.75	0.25	>0.92	0.08
11/23/2009	12:00	90.78	8.48	80	0.85	>2.75	0.23	>0.92	0.08
11/23/2009	13:00	91.04	8.51	80	0.86	>2.75	0.20	>0.92	0.07
11/23/2009	14:00	90.06	8.42	80	0.88	>2.75	0.33	>0.92	0.11
11/24/2009	6:30	90.37	8.45	80	0.9	>2.75	0.21	>0.92	0.07
11/24/2009	7:30	89.32	8.35	80	0.9	>2.75	0.23	>0.92	0.08
11/24/2009	8:45	90.81	8.49	80	0.9	>2.75	0.15	>0.92	0.05
11/24/2009	10:00	90.65	8.47	80	0.9	>2.75	0.16	>0.92	0.05
11/24/2009	11:00	90.49	8.46	80	0.9	>2.75	0.17	>0.92	0.06

6. Third Party Lab Analysis

EASTERN ANALYTICAL, INC. DATA

Sample Date	Influent Flow Rate	Loading Rate	Coagulant	Coagulant Dose	Polymer Dose	Total Phosphorous-P	Total Phosphorous-P *	Ortho Phosphate-P	UV Absorption Wavelength	UV Transmittance	Solids Suspended	BOD
	(gpm)	(gpm/ft^2)		(ppm)	(ppm)	(mg/L)	(mg/L)	(mg/L)	(nm)	(%T/cm-1)	(mg/L)	(mg/L)
11/16/2009	85	8.0	Aluminum Sulfate	75	0.9	0.31	0.10	0.05	254	69	< 5	< 6
11/17/2009	85	8.0	Aluminum Sulfate	85	0.9	0.22	0.06	0.06	254	71	< 5	< 6
11/23/2009	90	8.5	Ferric Chloride	80	0.9	0.16	< 0.05	< 0.05	254	80		
11/24/2009	90	8.5	Ferric Chloride	80	0.9	0.10	< 0.05	< 0.05	254	79		

*** Total Phosphorus Dissolved filtered by laboratory through 0.45 micron filter**

eastern analytical

professional laboratory services

Karla King
AECOM (Concord, MA)
300 Baker AVE STE 290
Concord , MA 01742-2131

Subject: Laboratory Report

Eastern Analytical, Inc. ID:	84565
Client Identification:	Town of Newport, NH | WWTF Pilot
Date Received:	11/17/2009

Dear Ms. King :

Enclosed please find the laboratory report for the above identified project. All analyses were performed in accordance with our QA/QC Program. Unless otherwise stated, holding times, preservation techniques, container types, and sample conditions adhered to EPA Protocol. Samples which were collected by Eastern Analytical, Inc. (EAI) were collected in accordance with approved EPA procedures. Eastern Analytical, Inc. certifies that the enclosed test results meet all requirements of NELAP and other applicable state certifications. Please refer to our website at www.eailabs.com for a copy of our NELAP certificate and accredited parameters.

The following standard abbreviations and conventions apply to all EAI reports:

Solid samples are reported on a dry weight basis, unless otherwise noted
< : "less than" followed by the reporting limit
> : "greater than" followed by the reporting limit
%R : % Recovery

Eastern Analytical Inc. maintains certification in the following states: Connecticut (PH-0492), Maine (NH005), Massachusetts (M-NH005), New Hampshire/NELAP (1012), Rhode Island (269) and Vermont (VT1012).

The following information is contained within this report: Sample Conditions summary, Analytical Results/Data, Quality Control data (if requested) and copies of the Chain of Custody. This report may not be reproduced except in full, without the the written approval of the laboratory.

If you have any questions regarding the results contained within, please feel free to directly contact me or the chemist(s) who performed the testing in question. Unless otherwise requested, we will dispose of the sample(s) 30 days from the sample receipt date.

We appreciate this opportunity to be of service and look forward to your continued patronage.

Sincerely,

Lorraine Olashaw

Lorraine Olashaw, Lab Director

12.4.09
Date

4
# of pages (excluding cover letter)

SAMPLE CONDITIONS PAGE

Eastern Analytical, Inc. ID#: 84565

Client: **AECOM (Concord, MA)** Client Designation: **Town of Newport, NH | WWTF Pilot**

Temperature upon receipt (°C): 3 **Received on ice or cold packs (Yes/No): Y**

Lab ID	Sample ID	Date Received	Date Sampled	Sample Matrix	% Dry Weight	Exceptions/Comments (other than thermal preservation)
84565.01	IDI Eff	11/17/09	11/16/09	aqueous		Adheres to Sample Acceptance Policy
84565.02	IDI Eff	11/17/09	11/17/09	aqueous		Adheres to Sample Acceptance Policy

Samples were properly preserved and the pH measured when applicable unless otherwise noted. Analysis of solids for pH, Flashpoint, Ignitibility, Paint Filter, Corrosivity, Conductivity and Specific Gravity are reported on an "as received" basis.

All results contained in this report relate only to the above listed samples.

References include:
1) EPA 600/4-79-020, 1983
2) Standard Methods for Examination of Water and Wastewater : Inorganics, 19th Edition, 1995; Microbiology, 20th Edition, 1998
3) Test Methods for Evaluating Solid Waste SW 846 3rd Edition including updates IVA and IVB
4) Hach Water Analysis Handbook, 2nd edition, 1992

LABORATORY REPORT

Eastern Analytical, Inc. ID#: 84565

Client: **AECOM (Concord, MA)** Client Designation: **Town of Newport, NH | WWTF Pilot**

Sample ID:	IDI Eff	IDI Eff						
Lab Sample ID:	84565.01	84565.02						
Matrix:	aqueous	aqueous						
Date Sampled:	11/16/09	11/17/09	**Analytical**		**Analysis**			
Date Received:	11/17/09	11/17/09	**Matrix**	**Units**	**Date**	**Time**	**Method**	**Analyst**
Solids Suspended	< 5	< 5	AqTot	mg/L	11/23/09	16:30	2540D	AAM
Alkalinity Total (CaCO3)	**95**	**99**	AqTot	mg/L	11/24/09	10:23	2320B	SEL
Total Phosphorus-P	**0.31**	**0.22**	AqTot	mg/L	11/19/09	6:00	365.3	JCC
Total Phosphorus-P	**0.10**	**0.06**	AqDis	mg/L	11/19/09	6:00	365.3	JCC
Ortho Phosphate-P	**0.05**	**0.06**	AqTot	mg/L	11/17/09	18:30	365.3	JCC
BOD	< 6	< 6	AqTot	mg/L	11/18/09	10:50	5210B	AAM
UV Absorption Wavelength	**254**	**254**	AqTot	nm	11/17/09	18:00	5910B	JCC
UV Transmittance	**69**	**71**	AqTot	%T/cm-1	11/17/09	18:00	5910B	JCC

Total Phosphorus Dissolved filtered by laboratory through 0.45 micron filter.

LABORATORY REPORT for Eastern Analytical, Inc. ID#: 84810

Client Designation: **Town of Newport, NH | WWTF Pilot**

PRELIMINARY DATA

Sample ID	Parameter	Result	Units	Analyst	Date/Time Sampled	Date/Time Analyzed	Analytical Matrix	Method
IDI Eff	Total Phosphorus-P	0.16	mg/L	JCC	11/23/2009 14:00	11/30/2009 6:00:00	AqTot	365.3
IDI Eff	Total Phosphorus-P	< 0.05	mg/L	JCC	11/23/2009 14:00	11/30/2009 6:00:00	AqDis	365.3
IDI Eff	Ortho Phosphate-P	< 0.05	mg/L	JCC	11/23/2009 14:00	11/25/2009 9:20:00	AqTot	365.3
IDI Eff	UV Transmittance	80	%T/cm-1	JCC	11/23/2009 14:00	11/25/2009 9:15:00	AqTot	5910B
IDI Eff	UV Absorption Wavelength	254	nm	JCC	11/23/2009 14:00	11/25/2009 9:15:00	AqTot	5910B

84810.01 End of data for sample: IDI Eff

LABORATORY REPORT for Eastern Analytical, Inc. ID#: 84811

Client Designation: **Town of Newport, NH | WWTF Pilot**

PRELIMINARY DATA

Sample ID	Parameter	Result	Units	Analyst	Date/Time Sampled	Date/Time Analyzed	Analytical Matrix	Method
IDI Eff	Total Phosphorus-P	0.10	mg/L	JCC	11/24/2009 14:00	11/30/2009 6:00:00	AqTot	365.3
IDI Eff	Total Phosphorus-P	< 0.05	mg/L	JCC	11/24/2009 14:00	11/30/2009 6:00:00	AqDis	365.3
IDI Eff	Ortho Phosphate-P	< 0.05	mg/L	JCC	11/24/2009 14:00	11/25/2009 9:20:00	AqTot	365.3
IDI Eff	UV Transmittance	79	%T/cm-1	JCC	11/24/2009 14:00	11/25/2009 9:15:00	AqTot	5910B
IDI Eff	UV Absorption Wavelength	254	nm	JCC	11/24/2009 14:00	11/25/2009 9:15:00	AqTot	5910B

84811.01 End of data for sample: IDI Eff

Page 1 of 2

CHAIN-OF-CUSTODY RECORD

FOR LAB

84565

3

BOLD FIELDS REQUIRED. PLEASE CIRCLE REQUESTED ANALYSIS.

Sample I.D.	Sampling Date/Time *If Composite, Indicate Both Start & Finish Date/Time	Matrix (see below)	Grab/*Composite	VOC: 524.2 / 524.2 BTEX / 524.2 MTBE only	VOC: 8260B 624 VTICs / 1,4 Dioxane EDB DBCP	VOC: 8021B BTEX HALOS	VOC: 8015B GRO MEGRO MAVPH	SVOC: 8270C 625 SVTICs / ABN A BN PAH	SVOC: TPH8100 L1 L2	SVOC: 8015B DRO MEDRO MAEPH	SVOC: 608 PEST/PCB / PEST 8081A PCB 8082	SVOC: Oil & Grease 1664 TPH 1664	TCLP: TCLP 1311 ABN Metals / VOC Pest Herb	Metals: Dissolved Metals (list below)	Metals: Total Metals (list below)	Inorganics: TS TSS TDS Spec. Con.	Inorganics: Br Cl F SO_4 / NO_2 NO_3 NO_2/NO_3	Inorganics: BOD CBOD T. Alk.	Inorganics: TKN NH_3 T. Phos.	Inorganics: pH T. Res. Chlorine	Inorganics: COD Phenols TOC	Inorganics: Total Cyanide Total Sulfide	Inorganics: Reactive Cyanide Reactive Sulfide / Flashpoint Ignitability	Micro: T. Coliform E. Coli / F. Coliform	Micro: Enterococci / Heterotrophic Plate Count	Other: UV TRANS 254	Other	Other	# of Containers	Notes MeOH Vial #
ORTHO PHOS IDI EFF	11/16/09 0800-1400	WW	C																X										1	
T. PHOS " "																			X											
BOD " "																		X												
ALKALINITY " "																		X												
UVT254 " "																										X				
DIS-T-PHOS " "																			X											

MATRIX: A-AIR; S-SOIL; GW-GROUND WATER; SW-SURFACE WATER; DW-DRINKING WATER; WW-WASTE WATER

PRESERVATIVE: H-HCL; N-HNO_3; S-H_2SO_4; Na-NaOH; M-MEOH

PROJECT MANAGER: KARLA KING

COMPANY: AECOM

ADDRESS: 300 BAKER AVE. STE. 290

CITY: CONCORD STATE: MA ZIP: 01742

PHONE: 978-371-4000 EXT.:

FAX: 978-371-2468

E-MAIL: KARLA.KING@AECOM.COM

SITE NAME: TOWN OF NEWPORT NH WWTF PILOT

PROJECT #:

STATE: NH MA ME VT OTHER:

REGULATORY PROGRAM: NPDES: RGP POTW STORMWATER OR GWP, OIL FUND, BROWNFIELD OR OTHER:

QUOTE #: PO #:

DATE NEEDED: NORMAL TURN AROUND

TEMP. 3 °C

ICE? YES NO

QA/QC REPORTING LEVEL A B C OR MA MCP PRESUMPTIVE CERTAINTY

REPORTING OPTIONS

PRELIMS: YES OR NO

IF YES: FAX OR PDF

ELECTRONIC OPTIONS

NO FAX E-MAIL PDF EQUIS

SAMPLER(S): K. KING, R. BOONE, A. GREENLEAF

Relinquished By	Date	Time	Received By
Russell Boone	11/17/09	1315	R. [illegible]
R. [illegible]	11/17/09	1438	Jennifer [illegible]

METALS: 8 RCRA 13 PP FE, MN PB, CU

OTHER METALS:

DISSOLVED METALS FIELD FILTERED? YES NO

NOTES: (IE: SPECIAL DETECTION LIMITS, BILLING INFO, IF DIFFERENT)

IDI Dis T-Phos Samples will need to be filtered –

SITE HISTORY:

SUSPECTED CONTAMINATION:

FIELD READINGS:

Page 2 of 2

CHAIN-OF-CUSTODY RECORD

BOLD FIELDS REQUIRED. PLEASE CIRCLE REQUESTED ANALYSIS.

FOR I

84565

4

				VOC				SVOC					TCLP	METALS		INORGANICS									MICRO		OTHER				
SAMPLE I.D.	SAMPLING DATE/TIME *IF COMPOSITE, INDICATE BOTH START & FINISH DATE/TIME	MATRIX (SEE BELOW)	GRAB/*COMPOSITE	524.2 524.2 BTEX 524.2 MTBE ONLY	8260B 624 VTICs 1, 4 DIOXANE EDB DBCP	8021B BTEX HALOS	8015B GRO MEGRO MAVPH	8270C 625 SVTICs ABN A BN PAH	TPH8100 L1 L2	8015B DRO MEDRO MAEPH	608 PEST/PCB PEST 8081A PCB 8082	OIL & GREASE 1664 TPH 1664	TCLP 1311 ABN METALS VOC PEST HERB	DISSOLVED METALS (LIST BELOW)	TOTAL METALS (LIST BELOW)	TS TSS TDS SPEC. CON.	Br Cl F SO_4 NO_2 NO_3 NO_2/NO_3	BOD CBOD T. ALK.	TKN NH_3 T. PHOS.	pH T. RES. CHLORINE	COD PHENOLS TOC	TOTAL CYANIDE TOTAL SULFIDE	REACTIVE CYANIDE REACTIVE SULFIDE FLASHPOINT IGNITABILITY	T. COLIFORM E. COLI F. COLIFORM	ENTEROCOCCI HETEROTROPHIC PLATE COUNT	UV TRANS 254			# OF CONTAINERS	NOTES MEOH VIAL #
ORTHO PHOS IDI EFF	11/17/09 0700-1300	WW	C																X										1	
T. PHOS																			X											
BOD																		X												
ALKALINITY																		X												
UVT254																										X				
DIS-T-PHOS																			X											

MATRIX: A-AIR; S-SOIL; GW-GROUND WATER; SW-SURFACE WATER; DW-DRINKING WATER; WW-WASTE WATER
PRESERVATIVE: H-HCL; N-HNO_3; S-H_2SO_4; Na-NaOH; M-MEOH

PROJECT MANAGER: KARLA KING
COMPANY: AECOM
ADDRESS: 300 BAKER AVE. STE. 290
CITY: CONCORD STATE: MA ZIP: 01742
PHONE: 978-371-4000 EXT.:
FAX: 978-371-2468
E-MAIL: KARLA.KING@AECOM.COM
SITE NAME: TOWN OF NEWPORT NH WWTF PILOT
PROJECT #:
STATE: NH MA ME VT OTHER:
REGULATORY PROGRAM: NPDES: RGP POTW STORMWATER OR GWP, OIL FUND, BROWNFIELD OR OTHER:
QUOTE #: PO #:

DATE NEEDED: NORMAL TURN AROUND

TEMP. 3 °C
ICE? YES NO

QA/QC REPORTING LEVEL
A B C
OR
MA MCP PRESUMPTIVE CERTAINTY

REPORTING OPTIONS
PRELIMS: YES OR NO
IF YES: FAX OR PDF

ELECTRONIC OPTIONS
NO FAX E-MAIL PDF EQUIS

SAMPLER(S): K. KING, R. BOONE, A. GREENLEAF

RELINQUISHED BY:	DATE:	TIME:	RECEIVED BY:
Russell Boone	11/17/09	1315	R. Lede[illegible]
R. Leden[illegible]	11/17/09	1438	[illegible]

METALS: 8 RCRA 13 PP FE, MN PB, CU
OTHER METALS:
DISSOLVED METALS FIELD FILTERED? YES NO
NOTES: (IE: SPECIAL DETECTION LIMITS, BILLING INFO, IF DIFFERENT)

SITE HISTORY:
SUSPECTED CONTAMINATION:
FIELD READINGS:

eastern analytical, inc. professional laboratory services 25 CHENELL DRIVE | CONCORD, NH 03301 | TEL: 603.228.0525 | 1.800.287.0525 | FAX: 603.228.4591 | E-MAIL: CUSTOMER_SERVICE@EAILABS.COM | WWW.EAILABS.COM

(WHITE: ORIGINAL GREEN: PROJECT MANAGER)

7. Conclusions

The pilot study results for the Newport WWTP pilot study demonstrate that the DensaDeg® is capable of effectively removing phosphorus prior to discharge. The process train, a high-rate solids contact clarifier/thickener, is a viable solution for the wastewater treatment facility.

Specific conclusions are as follows:

- Aluminum Sulfate Chemistry: The DensaDeg® clarifier was tested with several different chemical dosages of alum at loading rates of 5 to 8 gpm/ft^2. The optimal coagulant dose during these runs was between 65-85 ppm of alum. The clarified turbidity during these runs ranged between 1.3 to 2.3 NTU. The total effluent phosphorus for these doses was 0.06-0.30 mg/L.

- Ferric Chloride Chemistry: The DensaDeg® clarifier was tested with several different chemical dosages of ferric chloride at loading rates of 5 to 8.5 gpm/ft^2. The optimal coagulant dose during these runs was between 55-80 ppm of ferric chloride. The clarified turbidity during these runs ranged between 0.5 to 1.0 NTU. The total effluent phosphorus for these doses was 0.05-0.30 mg/L.

- Installation Potential: This pilot study, in conjunction with data from previous pilot studies and full-scale installations, provided sufficient information to design a full-scale DensaDeg® for this application. The data shows that the DensaDeg® technology is able to meet the NPDES permitted seasonal limits of less than 0.42 mg/L P between April 1 and October 31, and less than 1.0 mg/L P between November 1 and March 31. Furthermore, the DensaDeg® was able to meet the Engineer's goals of 0.35 mg/L P and 0.10 mg/L P. During the limited testing window, both coagulants proved capable of meeting or exceeding these goals.

Newport Wastewater Treatment Plant
Newport, NH

Hydrotech Discfilter Pilot Study Report

Pilot Testing Period:
November 2 - 20, 2009

I. Kruger Inc.

Final Report